Microsc. Microanal. 21 (Suppl 3), 2015
doi:10.1017/S1431927615006029 Paper No. 0523

Synthesis of Ti-Nb-Ta-Mn Alloys by Mechanical Alloying

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Due to the technical advancement, the average age and life expectancy of human beings have been continuously increase, this may produce degenerative diseases, which leads to degradation of the mechanical properties of the bone. Metallic materials are widely used as implants under load-bearing conditions [1,2]. The 316L stainless steels, Co-Cr and Co-Cr-Mo alloys have some disadvantages like high elastic modulus (E) (around 200 GPa, which is very high compared with E of bones, which is around 2 to 30 GPa) [3]. Ti-based alloys are the beneficial materials to re-place the damaged bone due to their excellent mechanical properties, corrosion resistance and biocompatibility. This work studies the synthesis of Ti-30Nb-13Ta-6Mn placed in 250 ml hardened steel vial and milled in argon atmosphere through planetary mill. Also 2 wt. % of stearic acid was added as lubricant in the milling process. The powders were milled for 4 and 50 h. Further the Ti-Nb-Ta-Mn powders synthetized have been characterized by X-ray diffraction, scanning and transmission electron microscopy. Figure 1 shows the morphology of Ti-30Nb-13Ta-6Mn alloy milled powders at 4 and 50 h. Figure 1(a) shows the agglomerated particles with equi-axial morphology with maximum size of ~60 μm and figure 1(b) shows an irregular morphology with a size ~ 40 μm for 4 and 50 h of milling respectively. Figure 2 shows the XRD pattern of Ti-30Nb-13Ta-6Mn powders milled for 4 and 50h. The XRD pattern reveals that there is no formation of intermetallic compounds between Ti, Nb, Ta and Mn. After 50 hrs of milling, the strongest Nb, Ta and Mn peaks were disappears due at the formation of a solid solution with Ti. It is possible to observe that there are some peaks of Ti and Mn present inside the amorphous hump. The 4 h of milled powders of all zones exhibits the presence of crystalline phases without amorphous phases as showed in figure 3(a). By other hand at 50 h of milling, the TEM micrograph clearly shows the mixing of amorphous phases and crystalline phases as showed in figure 3(b). The results indicate that the Ti-30Nb-13Ta-6Mn alloy formed through mechanical alloying. The energy given by mechanical alloying process was sufficient to increase the solubility between Ti, Nb, Ta and Mn. The increased surface energy (due to the reduction of crystallite size) and elastic strain energy (due to the increase of dislocations density) were responsible for the increase in solid solubility. At 50h of milling the Ti-30Nb-13Ta-6Mn alloy is a mixing between crystalline and amorphous phases.

References

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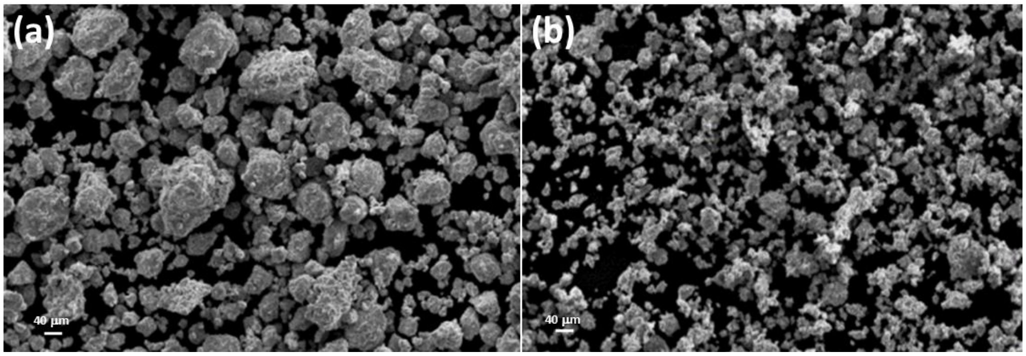

Figure 1. SEM images of Ti-30Nb-13Ta-6Mn powder milled (a) 4h and (b) 50 h.

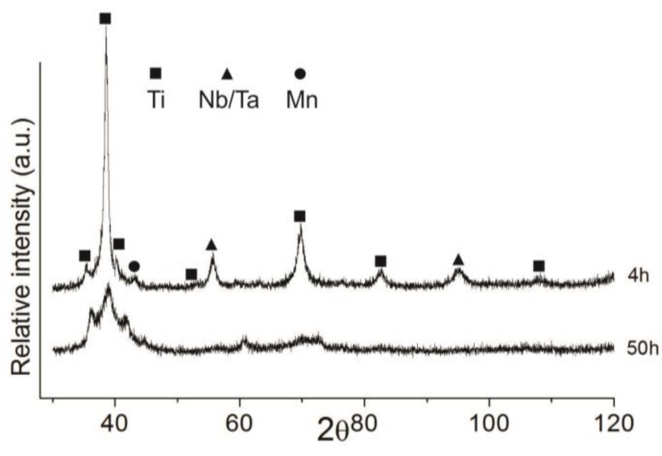

Figure 2. XRD pattern of Ti-30Nb-13Ta-6Mn milled at 4 and 50 h.

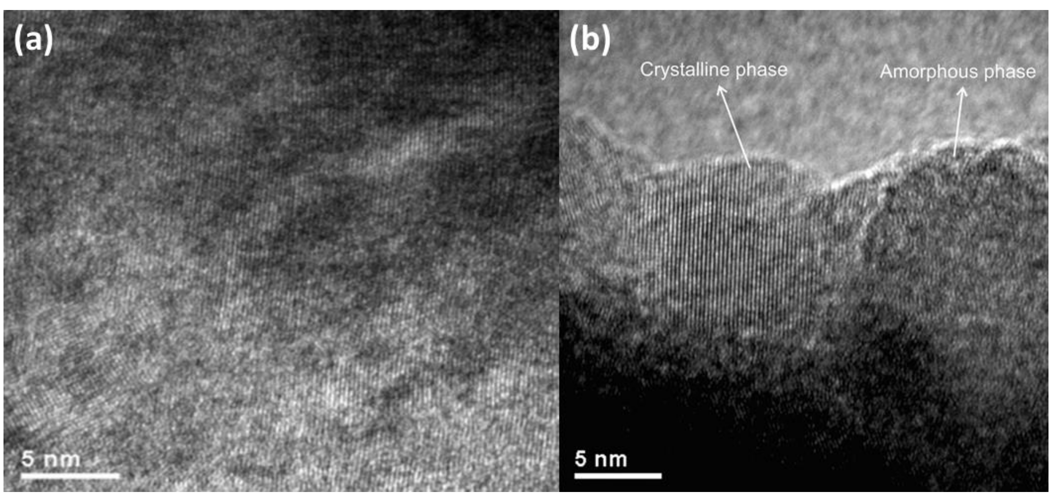

Figure 3. TEM images of Ti-30Nb-13Ta-6Mn powders milled at (a) 4 and (b) 50 h.